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OPTIMIZATION AND ANALYSIS OF PROCESS PARAMETER FOR TUNGSTEN INERT GAS WELDING BASED ON TAGUCHI METHOD

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ABSTRACT

The activated TIG (ATIG) welding process mainly focuses on increasing the depth of penetration and the reduction in the width of weld bead has not been paid much attention. The shape of a weld in terms of its width-to-depth ratio known as aspect ratio has a marked influence on its solidification cracking tendency. Properties include Tensile strength, Impact force, Hardness etc. Modeling of weld bead shape is important for predicting the quality of welds. In an attempt to model the welding process for predicting the bead shape parameters (also known as bead geometry parameters) of welded joints, modeling and optimization of bead shape parameters in tungsten inert gas (TIG) welding process has been tried in the present work. an attempt has been made to predict the bead shape strength. In the study which parameter is most effectively effect the weld strength. Weld strength varies under various conditions. By using Taguchi and ANNOVA technique an optimal solution is find out, which provides us an optimal results of the varying condition.

Keywords: Tungsten Inert gas Welding, Taguchi Method, Ultimate Load, Analysis of Variance, Universal Testing Machine,Minitab, Taguchi.

I INTRODUCTION

Modern welding technology started just before the end of 19th century with the development of methods for a generating high temperature in localized zone. Welding generally requires a heat source to produce a high temperature zone to melt raw material, though it is possible to weld two metal pieces without much increasing temperature. There are different methods and standards adopted and there is still a continuous search for new and improved method of welding. TIG welding offers several advantages i.e. joining of dissimilar metals, low heat affected zone, absence of slag etc. In TIG welding operation, weld quality mainly depends on features of bead geometry, mechanical-metallurgical characteristics of the weld and various aspects of weld chemistry.

II WORKPIECE MATERIAL

Stainless steel- 304 has lower carbon to minimize carbide precipitation. It is less heat sensitive than other 18:8 steels. Used in high-temperature applications. Its wide application in Food processing equipment, particularly in beer brewing, milk processing & wine making, Kitchen benches, sinks, troughs, equipment and appliances, Springs,Heat Exchangers.

Table 1: Composition of Stainless Steel

Elements	C	Cr	Ni	P	Mn	Si
Composition	.08	20.15	10.5	.047	2	.73

III. TAGUCHI'S PHILOSOPHY

Taguchi's comprehensive system of quality engineering is one of the great engineering achievements of the 20th century. His methods focus on the effective application of engineering strategies rather than advanced statistical techniques. It includes both upstream and shop-floor quality engineering. Upstream methods efficiently use small-scale experiments to reduce variability and remain cost-effective, and robust designs for large-scale production and marketplace. Shop-floor techniques provide cost-based, real time methods for monitoring and maintaining quality in production. The farther upstream a quality method is applied, the greater leverages it produces on the improvement, and the more it reduces the cost and time.

Quality should be designed into the product and not inspect into it.

- Quality is the best achieved by minimizing the deviations from the target. The product or process should be so designed that it is immune to uncontrollable environmental variables.
- The cost of quality should be measured as a function of deviation from the standard and the losses should be measured system-wide.

IV. LIST OF EQUIPMENT

- Welding machine
- Gas cylinder
- Welding torch
- Electrode & filler rod

A. TIG Welding Machine

Itis precision engineered range of inverter based TIG machines, which are in compliance with set industrial benchmarks. Fabricated from superior quality raw materials, these machines are used to weld mild steel, stainless steel, copper & titanium. Our Inverter TIG Welding Machines are known amidst clients for accurate dimension and capability to deliver optimum performance for long time.

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TIG Welding Machine

B. Gas Cylinder

A compressed gas is any gas which when enclosed in a container gives:

An absolute pressure reading greater than 276 kPa (40 psi) at 21°C (70°F)

An absolute pressure greater than 717 kPa (104 psi) at 54°C (129.2°F)

Any flammable liquid having a vapor pressure greater than 276 kPa (40 psi) at 38°C (100.4°F).

PARAMETER VALUE UNITS

Physical state (gas, liquid, solid): Gas

Vapor density (Air = 1) : 1.38

Boiling point : -303.3

: -185.9 F

Freezing point : -308.9

: -189.4F

Solubility (H_20) : Slight

Odor and appearance: Colorless, odourless gas

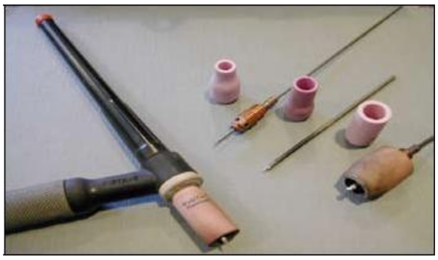
Stainless steel: length = 90 mm; width = 25 mm; width = 4mm;

Working length is 10 mm..

C. Welding Torch

TIG Torches feature Silicone Rubber torch bodies to reduce accidental damage during use and the loss of high frequency signal due to torch body cracking related to hard body plastic torch.

SR series TIG torches are built with reinforced cable assemblies constructed of light weight, hi-flex materials. Water cooled torches have three piece cable assemblies in standard lengths of 12’ or 25’. GTAW welding torches are designed for either automatic or manual operation and are equipped with cooling systems using air or water. The angle between the centerline of the handle and the centerline of the tungsten electrode, known as the head angle, can be varied on some manual torches according to the preference of the operator.



TIG Welding Torch

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Design of experiments (DOE)

The competition in the market has forced the manufactures to design and develop product / process with minimal cost as well as time. The design of experiment has emerged as an important tool for achieving objectives. DOE is a statistical technique that allows to run minimum number of experiments to optimize process. Major approaches in DOE are: factorial design, Taguchi method and response surface methodology. In the present work, Taguchi method is used to design and analyze the TIG welding process.

Table 1 L_{16} orthogonal array and output response

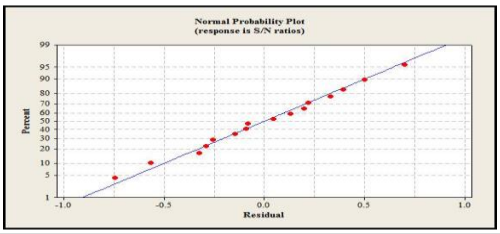
Table 2 Analysis of variance for ultimate load

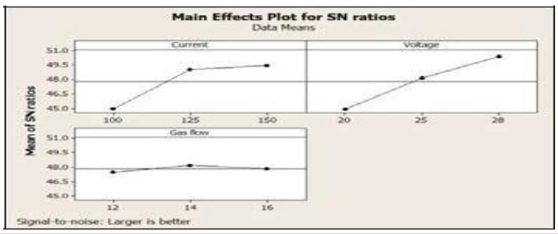
Source	DF	Seq SS	Adj MS	F	P
A	3	0.82	0.27	0.72	0.59
B	3	1.47	0.49	1.30	0.38
C	3	0.38	0.12	0.34	0.80
Error	6	2.27	0.37		
Total	15	4.97			

Level	Current(A)	Gas flow rate (B)	Filler road (C)
1	22.40	22.63	22.60
2	22.79	22.05	22.78
3	22.27	22.70	22.35
4	22.77	22.85	2.58
Delta	15	4.97	0.40
Rank	2	1	2

S.No.	A	B	C	Ultimate Load
1	90	12	1.5	13.9
2	90	14	2.0	13.6
3	90	16	2.5	12.3
4	90	18	3.0	13.1
5	100	12	2.0	13.8
6	100	14	1.6	12.0
7	100	16	3.0	14.8
8	100	18	2.5	14.5
9	110	12	2.5	12.8
10	110	14	3.0	12.1
11	110	16	1.6	13.8
12	110	18	2.0	13.2
13	120	12	3.0	13.7
14	120	14	2.5	12.8
15	120	16	2.0	13.8
16	120	18	1.6	14.8

Table 3 Response table for signal-to-noise ratio of ultimate load





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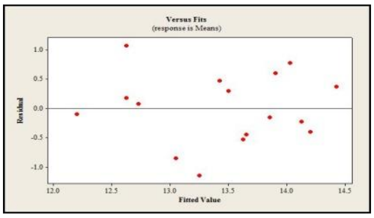
Main effect plots for ultimate load Normal probability plot of residual for ultimate load



Plot of residual vs. fitted ultimate load values

V. CONFIRMATORY TEST

Confirmatory test is conducted at optimal parameter combination (**A2 B3 C2**) to check the validity of the optimum welding condition. From the results of confirmatory test, it is found that optimum welding parametric condition produced maximum UL, this value shows the validation of the proposed optimization methodology

Obtained optimum parametric condition by Taguchi method		Obtained ultimate load by confirmatory test
Current (A)	100 A	Ultimate load = 15.6 MPa
Glass flow rate (B)	18 l/min	
Filler road (C)	2 mm	

VI CONCLUSIONS

This paper has described the use of Taguchi method and statistical techniques ANOVA and S/N ratio for analyzing and optimizing the ultimate load in TIG welding of stainless steel – mild steel specimens. From the study, the following conclusions are drawn

- From the ANOVA results, it is found that none of the welding parameter does not effecting the ultimate load.
- Main effects plots revel that current and gas flow rate are the factors which has considerable influence on ultimate load. Filler rod has small / lesser influence.
- The optimum welding condition obtained by Taguchi method is: current = 102A, gas flow rate = 190/min and filler rod = 2.15 mm.
- Confirmation test is confirms the improvement of the UL which also indicates the validity of the present optimization procedure by using Taguchi methodology.

- The use of the L_9 orthogonal array, with three control parameters allowed this study to be conducted with a sample of 18 work pieces.

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